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MATHEMATICS IN THE PROFESSIONAL SCHOOL.

GEORGE W. MYERS.

THE outlines which follow are intended only for the work of the professional school. The nature and scope of the mathematical work in the elementary school may be learned from the grade teachers' outlines to be published next month.

The need of the prospective mathematical teacher endeavoring, by a study of modes of presenting his work to pupils, to select and use only the best methods, has been warmly contested by good educational authority, but it is now generally conceded to be a part of his professional duty. The claim that a knowledge of subject-matter is all that is needed to insure professional efficiency in the mathematical teacher is nowadays confined, for the most part, to those whose preparation for professional service has been more or less faulty, and to the born teacher. The latter type is, of course, incapable of improvement, inasmuch as man cannot presume to improve upon the work of God. Strange to say, however, even the teachers by divine right are learning that native skill may be heightened by the right sort of training, while mere practice, unguided by trained intelligence, may go far to destroy heaven's handiwork.

If, however, the need of professional training for the teacher in general be conceded, it must be conceded to exist with twofold urgency for the teacher of elementary mathematics. Every argument for pedagogical study which applies to subjects in general applies with full force to mathematics. Furthermore, the teaching of no subject seems so prone as is mathematics to degrade into a sort of mere device-exemplifying and device-parading practice. The science which treats of the *form* of knowledge, it easily falls prey itself to a dead formalism. Of all the school subjects, sciences, or literatures, mathematics, therefore, is the most likely to fall under a system of mechanical routine. Hence it is the most difficult subject to present in such way as to call for the exercise of the reasoning faculties.

Moreover, unless mathematics can be so presented as to do this at every step, it loses its claims to a place in education. This is true, notwithstanding the fact that "mathematics is the science of *pure* reason," "the science of necessary conclusions," etc., because the *manner* of teaching a mathematical subject is even more important than the *matter*.

Form is many-sided; it presents many aspects to study. Mathematical subjects are, consequently, capable of a many-sided treatment. The prevailing idea that the whole problem of mathematical teaching can be given in a nutshell is very alluring, but very incorrect. In the course of years, mathematical teachers, who cater to *teachers* rather than to *teaching*, succeed in agglomerating their devices into a sort of plum-pudding composite which is very enticing to uneducated tastes. This has been the bane of mathematical teaching and the pitfall of the indiscriminating candidate for mathematical preferment. The pedagogical result of such practice is a crop of artificial devices reduced to text-book form, and labeled by the inventor a new method, calculated to revolutionize mathematical teaching. The professional outcome is a host of young teachers foisting fragmentary and second-hand notions of number upon children. The work done by this artificial product must all be undone later by such pupils as remain in school, while sound and complete notions of number must be implanted at a later period; but this is no check to the deviceful pedagogue, and so the unwholesome product grows on apace.

The situation cannot grow better in the elementary school until teachers cease laboring more diligently to evade a thorough grounding in both mathematical subject-matter and methodology than is necessary to master the whole field. Less method, and at the same time more method; less arithmetic, and more arithmetic, are the crying needs of even the best elementary schools of today. Method of the right sort, method built upon a sound knowledge of the subject, has promise in it; but without this foundation in knowledge it is, in many respects, worse than an entire lack of it. May the day speedily come when the proper sequence of subjects for the training teacher shall be

recognized by us all, and when the proper balance between scholarship and pedagogical training shall be struck!

The work of the first course outlined below will be academic. It will proceed on the assumption that suitable problems, dealing more with the affairs of modern life and less with pure imagination, promise more for the improvement of the teaching of arithmetic than do device-hunting and device-formulating. A notion of the subjects from which problems will be drawn may be derived from the list below. The character of these subjects will suggest the importance of teaching the pupil of arithmetic, among other things in the way of process and operation, also how arithmetic may be used to assist in the study of almost any subjects he may care to learn, and how and why it is that a good degree of arithmetical proficiency will be of service in any pursuit of life.

TOPICS FOR PROBLEMS.

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| 1. Simple scale drawing. | 18. Sun spots. |
| 2. City blocks and lots. | 19. Barometer. |
| 3. Paving streets. | 20. Levers, etc. |
| 4. House and furnishings. | 21. Graphical representation. |
| 5. Cost of living. | 22. Statistical studies. |
| 6. Farm account keeping. | 23. Geometrical surveying. |
| 7. Dairy farming. | 24. Time, latitude, and longitude. |
| 8. Habits of animals. | 25. Domestic science. |
| 9. Growth of twigs. | 26. Laboratory work. |
| 10. Vital statistics (death-rate). | 27. Observational astronomy. |
| 11. Physical measurements. | 28. Elementary algebra. |
| 12. Manual training. | 29. Changing slant of sun's rays. |
| 13. Wind pressure. | 30. Graphical representation of equations. |
| 14. Snow loads on roofs, roofing. | 31. Graphical representation of physical laws. |
| 15. Thermometry. | 32. Steam engine. |
| 16. Meteorology. | |
| 17. Nov. meteors. | |

Teachers will be required to select topics from this list and prepare sets of problems of such character as to build up a knowledge of the subject in the learner's mind.

The result will be sets of problems bearing on a single subject, each problem being a step in the process of unfolding the subject to the child. They will be miscellaneous as to process, and at the same time organically related as to thought-content.

In accordance with what has just been said, the mathematical course for the autumn quarter is academic in character and is to be followed during the winter by a pedagogical course based upon it. The class work in mathematics during the autumn will follow the lead of the other subjects so far as this is feasible. Essential requirements for substantial mathematical work are connectedness and continuity. To secure these desiderata the development of the course will also have a trend and unity of its own, the material for problems drawn from the work in the other subjects being organized and handled in an orderly and systematic way with reference to mathematical content. The right sort of correlation of subjects does not mean haphazard work, though too often it degenerates into an aimless scattering of the pupil's energy.

OUTLINES.

The mathematics of the professional school for the year will be given in three courses:

- I. An academic course in elementary mathematics.
- II. Pedagogy of elementary mathematics.
- III. Pedagogy of secondary mathematics.

These courses will succeed each other in the order of this enumeration.

The first of the three courses will include a survey of the mathematical topics which should be taught in a modern elementary school, together with a detailed study of such of these topics as time and circumstances will permit. The course having been planned primarily for teachers whose mathematical training has been faulty, or whose mathematical equipment is in need of a little burnishing, it will call for considerable real work in the solution of practical and modern problems. The plan of work will consist in the assignment to individual teachers of topics such as are enumerated a few paragraphs above for study and report, the teacher being required to make use of such arithmetic, algebra, or geometry as is needed to make the topic intelligible to children. The report will be criticised and discussed, then returned to the teacher for correction, if necessary; when satisfactory, the teacher may present it to a class. The

object of such work is evidently to train teachers in the preparation of material of their own for mathematical teaching, as well as to convince them, and indirectly pupils also, that mathematics will assist one in the achievement of almost anything he deems important in life. It means the teaching of arithmetic less for its own sake and more for the sake of the pupil's education. It means in a sense that mathematics is being subordinated to the demands of the other subjects and to the needs of the pupil; but this is not the only instance in which a science must for a time lose sight of its own interests that it may truly find them. In short, the aim will be to make the mathematics helpful to the other work—or rather to the pupil's educational interests—as a whole, but still to keep the work mathematical in its method and spirit.

The autumn quarter's work will be discussed and, so far as the foregoing plan will admit, will be presented under three subordinate headings: In October, "Mathematics of Grades 1, 2, and 3;" in November, "Mathematics of Grades 4, 5, and 6;" in December, "Mathematics of Grades 7 and 8."

The outlines which follow are not intended to indicate more than the general scientific and pedagogic principles in accordance with which the specific work of the class will be organized and administered. Perhaps the idea of the outlines can be best conveyed by the statement that they are intended to indicate only the order of ideas emphasized in the evolution of the numbering and relating faculties of the child.

A. OCTOBER OUTLINE.

- I. Indefinite comparison of lines, surfaces, solids, and general objects.
- II. Counting, numbering, crude measuring.
- III. Definite comparison of lines, surfaces, etc.
- IV. Measurement—direct and indirect; (1) linear, (2) surface, (3) solid, (4) weight, (5) time, etc.
- V. Addition and subtraction of whole numbers from 1–12.
- VI. Relating of (*a*) measured magnitudes, (*b*) of quantities.
- VII. Multiplication by 5; by 2; by 10.
- VIII. Division facts correlative with these multiplication facts.
- IX. Standard units and tables used: (1) cubic, liquid and dry measure, (2) weight, (3) United States money, (4) time.

X. Beginnings of addition, subtraction, multiplication, and division as arithmetical operations.

XI. Elementary uses of arithmetic.

XII. Addition and multiplication tables completed in the order the 4s, 11s, 12s, 3s, 6s, 9s, 8s, and 7s.

PEDAGOGICAL COURSE.

This course will take up a careful study of the principles in pursuance of which the work of the foregoing was planned. It will consider the place, kind, amount, and relation of the mathematics of the elementary school. It will enter into the psychology of number work to such an extent as the attainment and maturity of the class warrant.

Some knowledge of the way in which arithmetic, algebra, and geometry have come into their present place and relation in the curriculum is needed by every teacher of mathematics who aspires to some degree of proficiency in his work. Something of the history of the aims and purposes of elementary mathematical study will therefore be given.

The subject-matter of the course will be distributed and taken up under these heads:

- A. History of elementary mathematical teaching.
- B. Methodology of current teaching.
- C. Psychology of elementary mathematics.

ADDENDUM.

Proposed course for special teachers in mathematics and for mathematical supervisors:

REQUIRED WORK.

		Two-Year Course.	Three-Year Course.
Mathematics	- - - - -	6 Mj.	8 Mj.
Nature study	- - - - -	1 Mj.	2 Mj.
Geography	- - - - -	1 Mj.	2 Mj.
Geology	- - - - -	0	1 Mj.
Domestic science, or chemistry	-	1 Mj.	1 Mj.
Physics	- - - - -	1 Mj.	2 Mj.
Astronomy	- - - - -	1 Mj.	1 Mj.
Surveying and navigation	- - -	0	1 Mj.
Psychology and education	- -	2 Mj.	4 Mj.
Total	- - - - -	13 Mj.	22 Mj.

This scheme of courses is arranged to meet the needs of two classes of persons: (*a*) those who can afford the time (three years) necessary for thorough preparation for mathematical teaching in the public schools below university grade; and (*b*) those who can spare but two years for preparation.

In either of the courses five majors may be elected from any courses in schools or departments of the university for which the candidate is prepared.

Two of the six mathematical majors of the two-year course and three of the eight majors of the three-year course must be taken in the School of Education.